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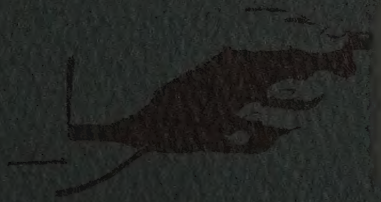
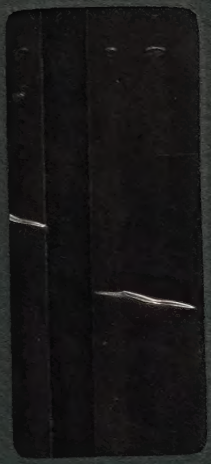
IWATSU

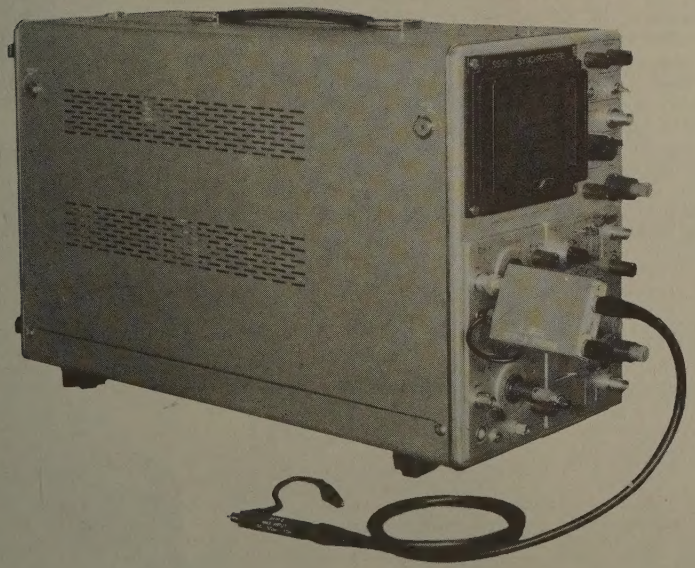
INSTRUCTION MANUAL



SOURCE FOLLOWER PROBE

SFP-2





INSTRUCTION MANUAL

SOURCE FOLLOWER PROBE

SFP-2

NOV. '1970

NOTICE

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While all procedures described herein have been verified by IWATSU/E–H, minor errors in translation may exist. In such event, please IWATSU/E–H.

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All Iwatsu products are warranted for a period of one year from date of delivery, but not exceed 18 months after delivery F.O.B. Japan. These products are warranted to be free from defects in material and workmanship, suitable for normal use and service under normal conditions, and able to meet any applicable specifications accepted in writing by IWATSU/E–H. No claim under the warranty will be accepted unless it is made in writing to IWATSU/E–H immediately after discovery of defect or in any case, within one year of delivery. No other warranty, express or inplied exists outside this warranty. IWATSU/E–H are not liable for any commercial loss or other consequential damages incurred or sustained as a result of any defective or nonconforming product. IWATSU/E–H's obligation with respect to losses is limited under this warranty, at IWATSU/E–H's option, either to the replacement (by delivery F.O.B.) or repair of its manufactured products which prove to be defective or nonconforming. This warranty does not apply to any products improperly applied or used or which have been subjected to intentional or negligent misuse or accident, or which have been in any way modified by others without the express written agreement of IWATSU/E–H.

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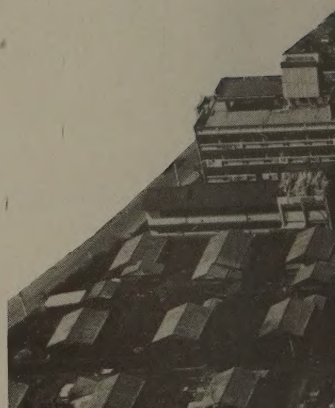

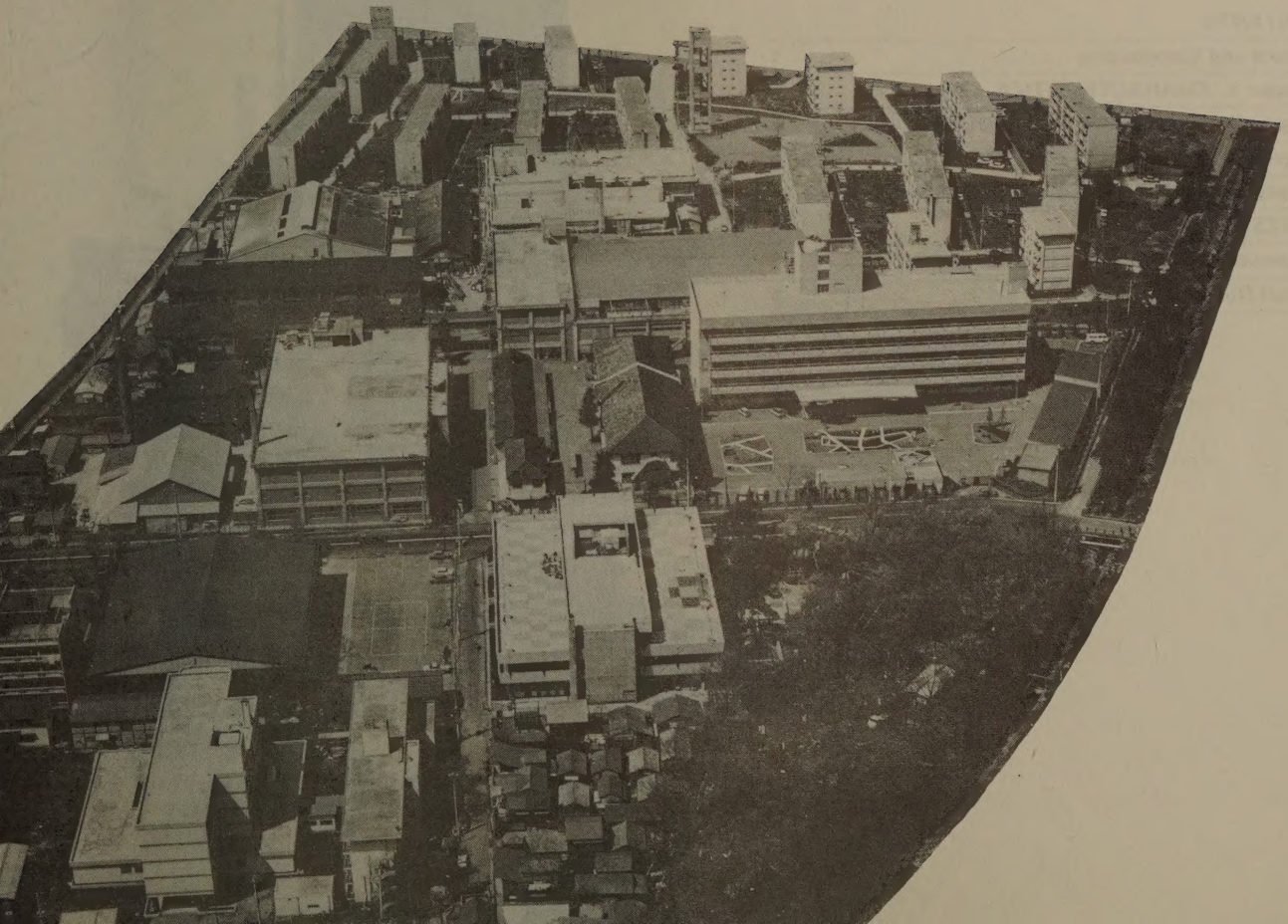

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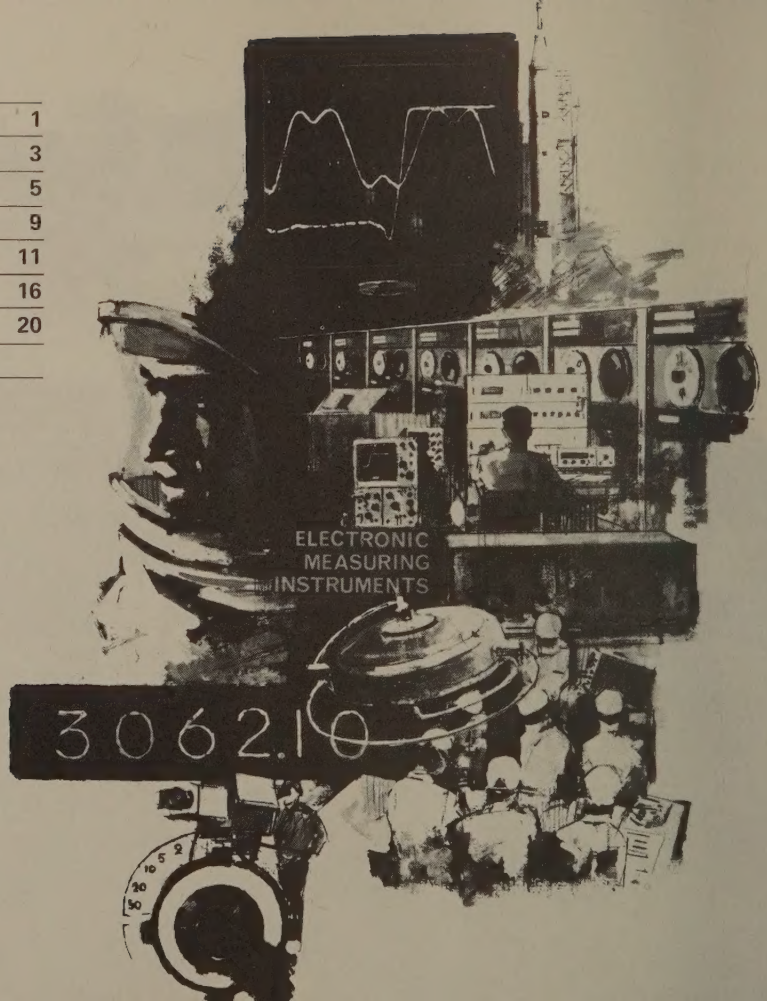


General

The SFP–2 super wideband active probe was developed to reduce the input capacitance of IWATSU's SS–311 synchroscope (–3 dB bandwidth, dc to 300 MHz). The SFP–2 Source Follower Probe gives a lower input capacity than the passive probe attached to the synchroscope and thereby allows use of the wide measurement frequency range (dc to 300 MHz –4 dB). Gain of the probe is 1.

Three auxiliary input attenuators (10 : 1 to 1000 : 1) extend the measurable input signal amplitude up to ±250 V (dc + ac p-p). DC blocking capacitors are also provided.

Composition

The SFP–2 Source Follower Probe is composed of the main probe and accessories.

Main Probe Unit

Accessories

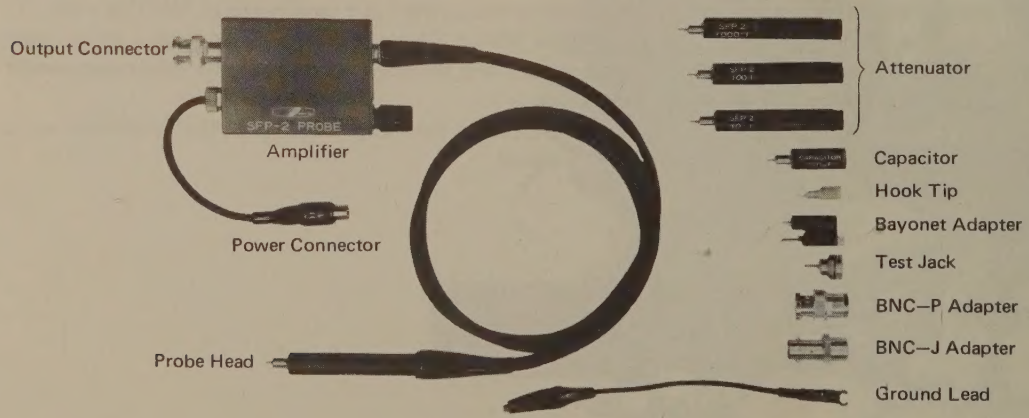
Attenuators
- 10 : 1, 100 : 1, 1000 : 1 ..... 1 ea.

DC Blocking Capacitors
- 0.01 μF (standard accessory) 1
- 0.003 μF (optional item)

Ground Lead 1

Bayonet Adapter 1
Hook Tip 1
BNC–P Adapter 1
BNC–J Adapter 1
Test Jack 1
Keeping Box for Main Probe Unit and Accessories 1

Main Probe Unit and Accessories



CHAPTER 1

CHARACTERISTICS

Gain
Frequency Characteristics
Square Wave Characteristics
Input Impedance
Attenuator Accuracy
Load Impedance
Maximum Input Voltage
Linear Range of Input and Output Voltages
Drift
DC OFFSET Voltage
Noise
Power Consumption

Gain

The input signal amplitude is attenuated by approx. 50% in the probe head. The signal loss is compensated for by the internal amplifier. The total gain of the probe is 1.

Frequency Characteristics

The overall frequency characteristics of the SFP–2 probe and Synchroscope SS–311 (frequency range dc to 300 MHz –3 dB) are dependent on the input signal coupling mode as shown below.

When the input signal is fed directly to the probe or through an attenuator:

DC to 300 MHz –4 dB

When a dc blocking capacitor is used:

0.01 μF	Approx. 15 Hz to 300 MHz	–4 dB
0.003 μF	Approx. 50 Hz to 300 MHz	–4 dB

Square Wave Characteristics

The overall square wave characteristics of the SFP–2 probe and the synchroscope SS–311 are as follows.

Overshoot	less than 5 %
Ringing	less than 5 %
Matching distortion	less than 5 %
Sag	less than 5 %
Miscellaneous distortions	less than 5 %

Input Impedance

Probe head	1 megohm shunted by approx. 5 pF
Attenuator	
10 : 1	1 megohm shunted by approx. 2.5 pF
100 : 1	1 megohm shunted by approx. 2.0 pF
1000 : 1	1 megohm shunted by approx. 1.8 pF

Attenuator Accuracy Within ±3 %

Load Impedance 1 megohm shunted by approx. 14 pF (input impedance of synchroscope SS–311).

Maximum Input Voltage The allowable maximum input voltage is dependent on the input signal coupling mode as shown in Table 1–1.

Linear Range of Input and Output Voltages ±0.3 V ±5 %

Drift

Synchroscope trace vertical drift after 30 minute warm up is 2 mV/hour or less.

DC OFFSET Voltage ±0.7 V, continuously variable

Noise 0.5 mVp-p or less

Power Consumption +12 V dc 0.12 A
–12 V dc 0.1 A

Table 1–1

Input Signal Coupling Mode	Maximum Input Voltage
Direct coupling to probe	dc ±10 V ac 20 Vp-p
Through attenuator	10 : 1 dc ±100 V ac 200 Vp-p
	100 : 1 dc ±250 V ac 500 Vp-p
	1000 : 1 dc ±250 V ac 500 Vp-p
Dielectric strength of DC blocking capacitor (Overall maximum input signal voltage is restricted by the probe head or attenuator following the capacitor.)	dc ±500 V ac 1000 Vp-p

CHAPTER 2

OPERATING PROCEDURE

Connection to the Synchroscope
Power Supply Connector
Output connector

Measurement
Before Applying an Input Signal
Attenuator
AC coupling measurement
DC OFFSET adjustment
Use of accessories

Connection to the Synchroscope

Unike the ordinary passive probe, the SFP–2 active probe requires that some precautions be observed, as well as a working knowledge of the characteristics, features, and proper operating procedures of the SFP–2 probe.

If the precautions are not observed, the measurement accuracy may be impaired and damage to the probe or synchroscope may result.

Power Supply Connector

Turn the synchroscope's power switch OFF before connecting the probe's power connector to the PROBE POWER connector located on the synchroscope's front panel.

The source follower probe must be used with a plus and minus 12 V dc supply.

Output Connector

Connect the probe's output connector directly to the synchroscope SS–311's INPUT connector (input impedance 1 megohm shunted by approx. 14 pF).

Measurement

Before Applying an Input Signal

Check the input signal level. The maximum allowable input signal level of the probe, attenuator and capacitor is listed in Table 1–1.

Attenuator

The rated linear range of the probe, referenced to the input signal level, is ±0.3 V. An input signal higher than that value will result in waveform distortion and loss of measurement accuracy.

When measuring a signal larger than ±0.3 V in amplitude, connect an attenuator to the probe head in order to reduce the input signal level applied to the probe. The attenuator can be connected simply by inserting the attenuator on the probe tip.

It accomplishes nothing to feed an input signal to the probe exceeding the maximum linear input range (±0.3 V) and reducing the output signal by using the synchroscope VOLTS/CM switch since the input signal is not affected and only the distorted output signal is attenuated.

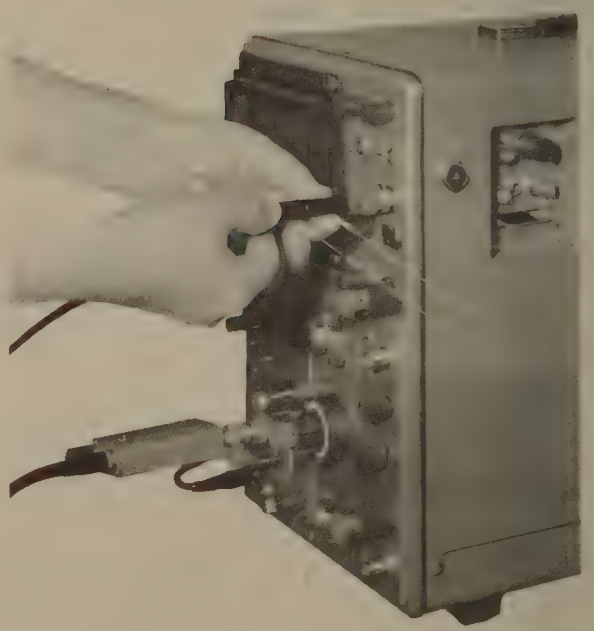
As with passive probes, the attenuator compensation, when used, must be correctly adjusted. Check the attenuator compensation by connecting the attenuator (with probe) to the synchroscope's CALIB signal output connector prior to measurement. If distortion is present in the output waveform, loosen part B as shown in Fig. 2–1, and adjust part A until the waveform is correctly compensated as shown in Fig. 2–2. Tighten part B after the adjustment is completed.

AC Coupling Measurement

An ac component superimposed on a dc voltage can be isolated by connecting the dc blocking capacitor to the probe head, or to the attenuator, when the attenuator is used. The capacitor can be mounted simply by inserting it on the probe or attenuator.

It should be noted that the dc blocking capacitor attenuates the extreme low frequency component of the input

Fig. 2–1 Attenuator phase calibration



signal. Refer to Chapter 1 for the overall frequency range of the capacitor and probe.

DC OFFSET Adjustment

When it is desired to measure only the ac component superimposed on a dc voltage when using the dc coupling mode, use of the DC OFFSET control enables the measurement without any loss in the lower frequency components. When an input signal is measured with the DC OFFSET control at the mid-position, a signal superimposed on a negative voltage is displayed below the CRT graticule center, and if the superimposed dc voltage is positive, the ac signal is displayed above the center line.

The ac signal component can be displayed on the graticule by turning the DC OFFSET control clockwise (when the dc level is negative) or counter clockwise (when the dc voltage is positive). Note that the distortion-free adjustment range of the DC OFFSET control is ±0.7 V.

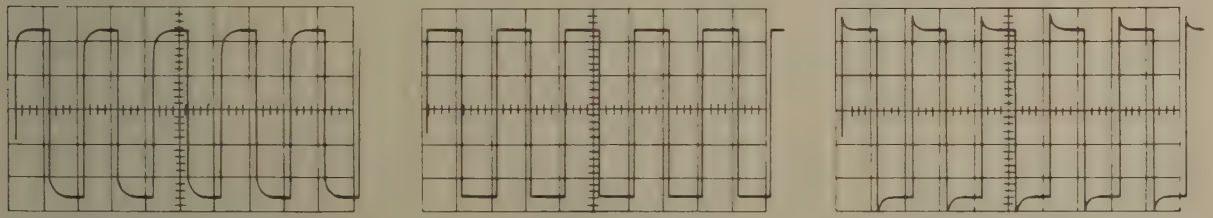
Use of Accessories

The accessories, other than the attenuator and the capacitor, are used as follows.

Ground Lead The ground lead is connected between the probe head and the input signal source (ground side).

When measuring a fast rising (or falling) signal, the ground lead inductive reactance may interfere with the measurement causing a ringing distortion in the displayed waveform. The bayonet adapter, or test jack, is used for measurement of these signals.

Fig. 2–2 Attenuator phase waveforms



Insufficient compensation

Correct compensation

Over compensation

Bayonet Adapter The bayonet adapter is connected to the probe head when measuring fast rising (or falling) input signals. The adapter minimizes ground lead length and reduces waveform distortion.

Hook Tip By mounting the hook tip on the probe tip, the probe can be hooked to the input signal source.

BNC Adapters When the signal source is a BNC connector, the BNC adapter is mounted on the probe tip. The BNC—J adapter is used when the signal output is a male BNC connector and the BNC—P adapter is for a female BNC output.

Test Jack The test jack is used to measure high frequency signals, particulary when it is desired to connect the probe directly to the signal source in order to eliminate the influence of the ground connection.

The test jack center conductor must be soldered to the signal source with as short a lead length as possible.

A copper sheet or foil must be soldered to the ground side of the signal source. The widest grounding connection is preferable. The ground conductor is then connected to the test jack by a nut.

The influence of the earth lead inductive reactance is minimized in this manner, and correct measurements can be made.

CHAPTER 3

OPERATION THEORY

. Attenuator
Probe

Attenuator

A resistive attenuator with parallel capacitance compensation is used to reduce the large amplitude input signal to the probe's linear input range (±0.3 V).

For example, the input resistance, low frequency attenuation ratio, and phase compensation of the 100 : 1 attenuator are represented by the following conditions.

$$\text{Input resistance} = R104 + \left(\frac{R107 \times Rp}{R107 + Rp}\right)$$

Low frequency attenuation ratio

$$= \left(\frac{R107 \times Rp}{R107 + Rp}\right) \Big/ \left(R104 + \frac{R107 \times Rp}{R107 + Rp}\right)$$

Phase compensation Conditions

$$\frac{C103 + Cp + Cs}{C102} = R104 \Big/ \left(\frac{R107 \times Rp}{R107 + Rp}\right)$$

where Rp : Input resistance of the probe (1 megohm)
Cp : Input capacitance of the probe (5 pF)
Cs : Stray capacitance in output side of attenuator
NOTE : R105 and R106 can be neglected in the calculation.

Probe

The probe head is composed of a source follower, FET TR1, and an emitter follower, TR2. The source follower, TR1, increases the input impedance and lowers the output impedance which is further lowered by TR2 in order to drive the output coaxial cable (75 ohms).

The electric characteristics of the FET, TR1, mainly

determine the frequency characteristics, dc voltage level, and maximum linear output voltage. Therefore, TR1 and R7 are specially selected for the best performance of the probe.

Diodes D1 and D2 conduct when an excessively large negative input signal is a applied to the gate of TR1. Conduction of these diodes cause a voltage drop across R2 and protects TR1 from damage. Diode D3 protects TR1 from overcurrent due to an excessively large positive input signal. The diode also compensates for any thermal variation in the FET characteristics. Diode D4 is a thermal compensator for TR2.

The probe head output is fed to the amplifier unit through a 75 ohm coaxial cable. The voltage gain of the probe head is approx. 50 %.

The probe head output signal is fed to the base of TR3 in the amplifier unit. MATCHING ADJ, R16, adjusts the coaxial cable termination. DIODE CUR. ADJ, R14, controls the current to D4. DC BAL, R25, balances the dc potential of TR3 and TR4. DC OFFSET, R23, offsets the dc component in input signal so that the signal ac component will be displayed at the center of the CRT graticule. The offset dc voltage is applied to the source or base of TR1 through TR4 via the DC OFFSET control, R23.

Potentiometer R18 and variable capacitors C7a and C7b are used for waveform adjustment.

The balanced signal amplified by TR3 and TR4 is fed to the bases of TR5 and TR6. The output signal is obtained from the collector of TR5. Output impedance is set at 50 ohms by R40.

The amplifier voltage gain is approximately 2 times. The input signal attenuated by approx. 50 % in the probe head is approximately doubled by the amplifier making the total gain of the probe head approximately 1.

CHAPTER 4

MAINTENANCE AND CALIBRATION

Maintenance
Probe head
Amplifier

Calibration
DC OFFSET
DIODE CUR. ADJ
DC BAL.
Output voltage level
Gain
Squarewave characteristics

Maintenance

Probe Head The cylinder type cover can be removed from the probe head by turning the head while holding the coaxial cord side of the head.

Amplifier The cover of the amplifier unit can be dismantled by removing eight mounting screws from the cover.

Calibration

For calibration of the SFP–2 probe, the amplifier cover must be removed.

DC OFFSET

Prior to calibration, measure the voltage between the DC OFFSET control wiper (a multi-turn potentiometer) and the chassis (test point 1 and chassis, see Fig. 4–3.)
Turn the potentiometer to set the voltage to zero.

DIODE CUR. ADJ

Adjust the current to diode D4 in the following manner.
(1) Set the voltage of DC OFFSET control, R23 of which center pin to zero volt.
(2) Turn the MATCHING ADJ, R16 (Fig. 4–3), fully clockwise to increase the resistance.
(3) Set the voltage across R15 (510 ohms) to 7.5 V by adjusting the DIODE CUR. ADJ R14 (Fig. 4–2). The diode current is 8 to 10 mA. This calibration must be carried out whenever the FET, TR1 is replaced.

DC BAL

This control balances the dc voltages in the balanced amplifier circuit. Adjust the DC BAL, R25 (Fig. 4–2), to equalize the collector voltages of TR3 and TR4 (Fig. 4–3).

Output Voltage Level

Adjust the ZERO ADJ., R44 (Fig. 4–2) to set the signal output terminal DC potential (test point 2, Fig. 4–3) to zero volts.

Gain

Connect the probe to the synchroscope's CAL OUT (Set the CALIBRATOR range to 50 mV.) and adjust the VOLTS/CM switch (with the VARIABLE control) to display the calibration output waveform at approx. 4 cm or 5 cm on the CRT graticule. Adjust the GAIN ADJ, R35 (Fig. 4–3), to set the overall gain of the probe to 1.

Fig. 4–1 Probe head

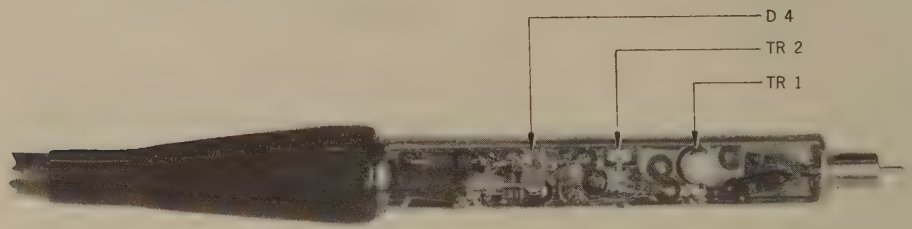


Fig. 4–2 Front of amplifier

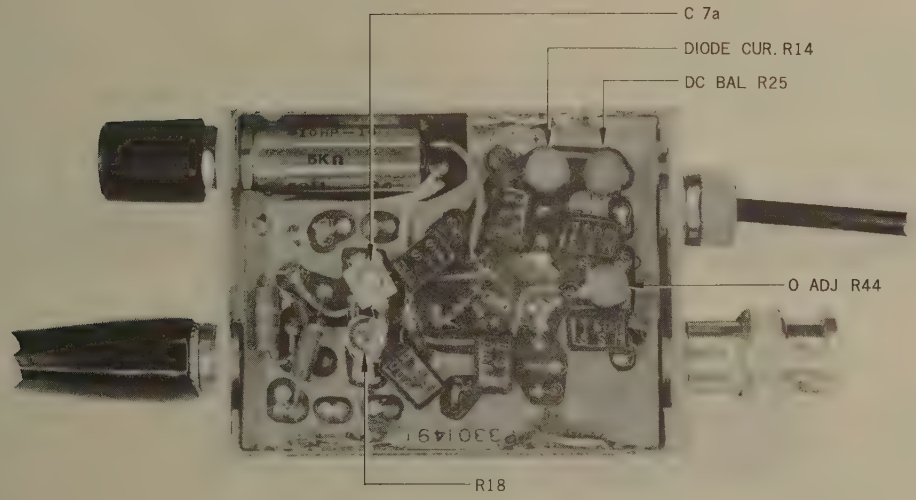
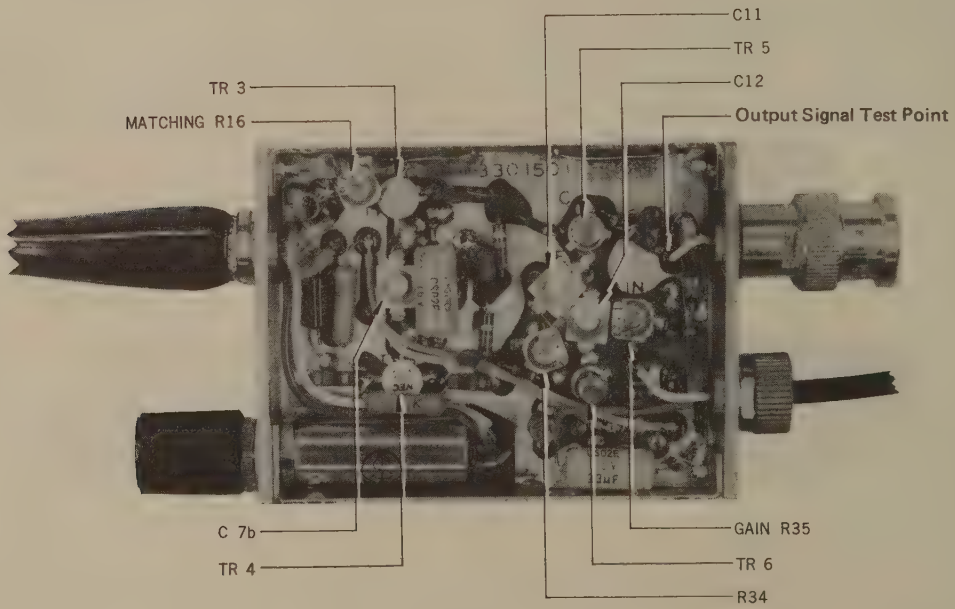


Fig. 4–3 Rear view of amplifier



Squarewave characteristics

The following instruments are required for the square wave characteristics calibration.

Square wave generator

Rise time	300 psec. or less
Output voltage	40 mVp-p or more
Output waveform	Must be calibrated.

Coaxial cable Characteristic impedance 50 ohms

50 ohm coaxial attenuator (AA series)
Attenuation 6 dB or more.

50 ohm termination load (BB50M 1)

Mount the BNC—J adapter on the probe head and connect the measurement set-up as follows.

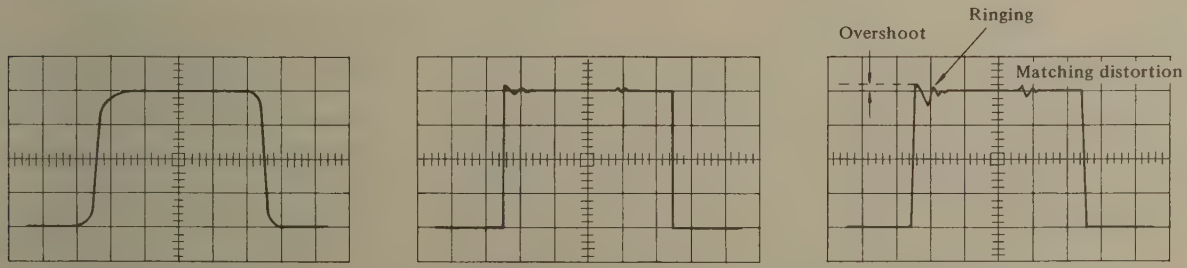
Square wave generator output — 50 ohm coaxial cable — 50 ohm coaxial attenuator — 50 ohm termination load — BNC - J adapter — probe head — synchroscope input

Set synchroscope SS–311 controls as shown below.

VOLTS/CM	10 mV
VARIABLE	CALIB
BAND WIDTH	FULL
A TIME/CM	A position at which one or two cycles of the square wave is displayed.

Adjust the square wave generator output so that the displayed waveform amplitude is approx. 4 cm. Position the display to the center of the CRT graticule. Adjust the A TIME/CM switch and A VARIABLE control to magnify the displayed square wave to an adequate width. Adjust the MATCHING ADJ, R16 (Fig. 4–3), R18, C7a, C7b, R34, C11 and C12 to set the displayed waveform to the correct form as shown in Fig. 4–4. After the compensation is completed, check the frequency response of the probe.

Fig. 4–4 Square wave high frequency characteristics



(a) Rounded leading edge

(b) Properly adjusted waveform

(c) Distortion in waveform

PARTS LIST

ORDERING INFORMATION

Replacement parts may be ordered through an IWATSU Representative or directly from the factory. To be certain of receiving the proper parts, always include the following information with the order.

a. Model Number and serial number of the instrument on which the parts will be installed.

b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.

c. Iwatsu part number.

For factory repair, contact the IWATSU agent and include the following information:

a. Model number and serial number of the instrument on which the work is to be performed.

b. Details concerning the nature of the malfunction: or, type of repair desired.

Shipping instruction will be sent to you promptly;

HOW TO USE THIS PARTS LIST

The parts list is divided into subsections corresponding to the schematic diagrams such as VERTICAL AMP, TRIG CIRCUIT, SWEEP GENERATOR, HORIZONTAL AMP, CRT CIRCUIT and POWER SUPPLY. Component locations can be determined from the schematic diagrams, each component appears only once in the parts list. At the beginning of each subsection are listed part numbers for any complete subassemblies in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to locate malfunctions to the lowest possible level of replacement part and thus avoid the time and cost involved in "over-repair".

ABBREVIATIONS

Cap. . . . . Capacitor
cer. . . . . ceramic
elect. tan. . . . tan-talum electlytic chemical condenser

Res. . . . . Resistor
comp. . . . . composition
W.W. . . . . wire wound

FET . . . . . Field Effect Transistor

DIODE
T. Diode . . . . Tunnel Diode
Z. Diode . . . . Zenner Diode

var. . . . . variable

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
ATTENUATOR & CAPACITOR		
C103	Cap., 70 pF, 30 WVDC, ±10 %, mica	74090-4750
C105	Cap., 350 pF, 30 WVDC, ±10 %, mica	74090-4770
C106	Cap., 0.01 μF, 500 WVDC, cer.	74060-2110
C107	Cap., 0.003 μF, 500 WVDC, cer.	74060-2100
R101	Res., 900 k, 1/4 W, ±1 %, carbon	74226-2560
R102	Res., 39, 1/8 W, ±5 %, compo.	74257-0860
R103	Res., 111 k, 1/4 W, ±1 %, carbon	74226-0060
R104	Res., 990 k, 1/4 W, ±1 %, carbon	74226-2600
R105	Res., 33, 1/8 W, ±5 %, compo.	74257-0850
R106	Res., 47, 1/8 W, ±5 %, compo.	74257-0140
R107	Res., 10.1 k, 1/4 W, ±1 %, carbon	74226-0030
R108	Res., 999 k, 1/4 W, ±1 %, carbon	74226-2850
R109	Same as R105	
R110	Res., 43, 1/8 W, ±5 %, compo.	74257-7890
R111	Res., 1 k, 1/4 W, ±1 %, carbon	74226-0010
L101	Inductor	74400-3450
PROBE		
C1	Cap., 0.001 μF, 25 WVDC, +100 − 0 %, cer.	74060-0550
C2	Cap., 0.001 μF, 25 WVDC, ±30 %, cer.	74060-2250
C3	Cap., 470 pF, 25 WVDC, ±30 %, cer.	74060-2790
C4	Cap., 56 pF, 25 WVDC, ±10 %, cer.	74050-6060
C5	Cap., 2 pF, 25 WVDC, ±0.5 pF, cer.	74050-6070
C6	Same as C1	
C7a	Cap., 3 − 8 pF, 50 WVDC, var. cer.	74110-0930
C7b	Same as C7a	
C8	Same as C1	
C9	Same as C1	
C10	Cap., 0.002 μF, 25 WVDC, +100 − 0 %, cer.	74060-1580
C11	Same as C7a	
C12	Cap., 8 − 20 pF, 50 WVDC, var. cer.	74110-0940
C13	Same as C1	
C14	Same as C1	
C15	Same as C1	
C16	Cap., 33 μF, 16 WVDC, ±20 %, elect. tan.	74120-3810
C17	Same as C1	
C18	Same as C16	
L1	Inductor (Matching Coil)	74400-5170

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
L2	Inductor	74470-1390
L3	Same as L2	
R1	Res., 1 M, 1/4 W, ±1 %, carbon	74226-0150
R2	Res., 20 k, 1/8 W, ±5 %, compo.	74261-0370
R3	Res., 33, 1/8 W, ±5 %, compo.	74261-0330
R4	Res., 560, 1/8 W, ±5 %, compo.	74261-0360
R5	Res., 240, 1/8 W, ±5 %, compo.	74261-0350
R6	Res., 3.9 k, 1/4 W, ±5 %, compo.	74253-1090
R7	Res., 2 k – 4.7 k, 1/4 W, ±5 %, compo. (The value of the resistor is selected offer the characteristics of transistor TR1.)	
R8	Res., 180, 1/8 W, ±5 %, compo.	74261-0340
R9	Res., 240, 1/4 W, ±5 %, compo.	74253-1580
R10	Same as R9	
R11	Res., 75, 1/8 W, ±5 %, compo.	74261-0210
R12	Res., 1 k, 1/4 W, ±5 %, compo.	74253-0500
R13	Res., 160, 1/2 W, ±2 %, carbon	74241-0250
R14	Res., 500, var. W.W	74331-0700
R15	Res., 510, 1/2 W, ±5 %, metal	74221-1660
R16	Res., 100, var. metal	74349-0740
R17	Res., 22, 1/8 W, ±5 %, compo.	74261-0320
R18	Res., 1 kΩ , var. metal	74349-0710
R19	Res., 82 Ω, 1/4 W, ±5 %, compo.	74253-0810
R20	Res., 820, 1/4 W, ±5 %, metal	74230-0490
R21	Same as R20	
R22	Res., 1 k, 1/2 W, ±5 %, metal	74221-1620
R23	Res., 5 k, var. W.W	74341-0410
R24	Res., 1.2 k, 1/2 W, ±5 %, metal	74221-1630
R25	Same as R14	
R26	Res., 75, 1/4 W, ±5 %, compo.	74253-0800
R27	Res., 150, 1/4 W, ±5 %, compo.	74253-0580
R28	Same as R27	
R29	Same as R27	
R30	Res., 120, 1/4 W, ±5 %, compo.	74253-0870
R31	Same as R31	
R32	Res., 10, 1/8 W, ±5 %, compo.	74261-0090
R33	Same as R32	
R34	Res., 500, var. metal	74349-0720
R35	Same as R16	
R36	Res., 390, 1/4 W, ±5 %, metal	74230-0550
R37	Same as R36	
R38	Same as R9	
R39	Same as R9	
R40	Res., 50, 1/2 W, ±1 %, carbon	74273-0020
R41	Res., 750, 1/4 W, ±5 %, metal	74230-0540
R42	Same as R41	
R43	Res., 51, 1/4 W, ±5 %, compo.	74253-0760
R44	Same as R14	
D1	Diode, 1S1544, selected	74040-3630
D2	Same as D1	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
D3	Diode, KD100	74040-4280
D4	Diode, 1S1992	74040-3930
D5	Z. Diode, RD-6A	74040-0790
TR1	FET, 2N4416, selected	74030-5220
TR2	Transistor, V327	74030-4120
TR3	Transistor, 2SC989	74030-4970
TR4	Same as TR3	
TR5	Transistor 2N4260	74030-3600
TR6	Same as TR6	
W1	Cable	52861-4006
W2	Cord	52861-4005
P1	Connector	74500-3890

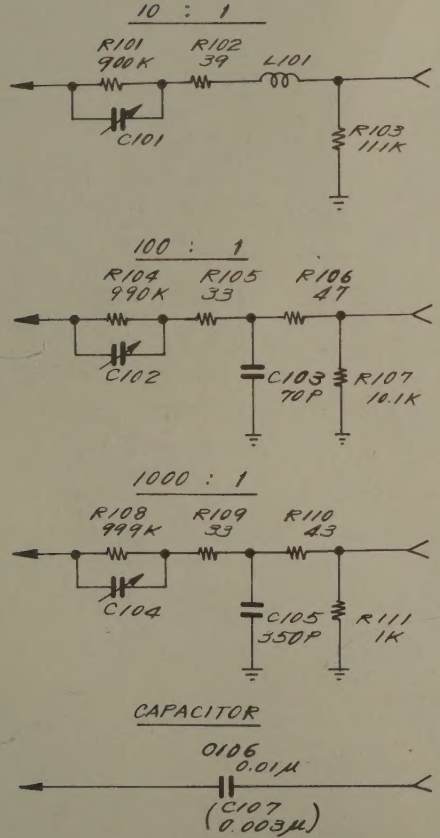
Abbreviations used in this manual are as follows:

- **For units:**

A	ampere
mA	milliampere
μA	microampere
nA	nanoampere (10^{-9} A)
dB	decibel
div (DIV)	division
g	gram
kg	kilogram
Hz	hertz
kHz	kilohertz
MHz	megahertz
GHz	gigahertz
m	meter
cm	centimeter
mm	millimeter
sec (SEC)	second
msec	millisecond
μsec	microsecond
nsec	nanosecond (10^{-9} sec)
psec	picosecond (10^{-12} sec)
F	farad
μF	microfarad
pF	picofarad
V	volt
mV	millivolt
μV	microvolt
VA	voltampere
W	watt
mW	milliwatt
Ω	ohm
kΩ	kilohm
MΩ	megaohm
rms	root mean square
p-p	peak to peak

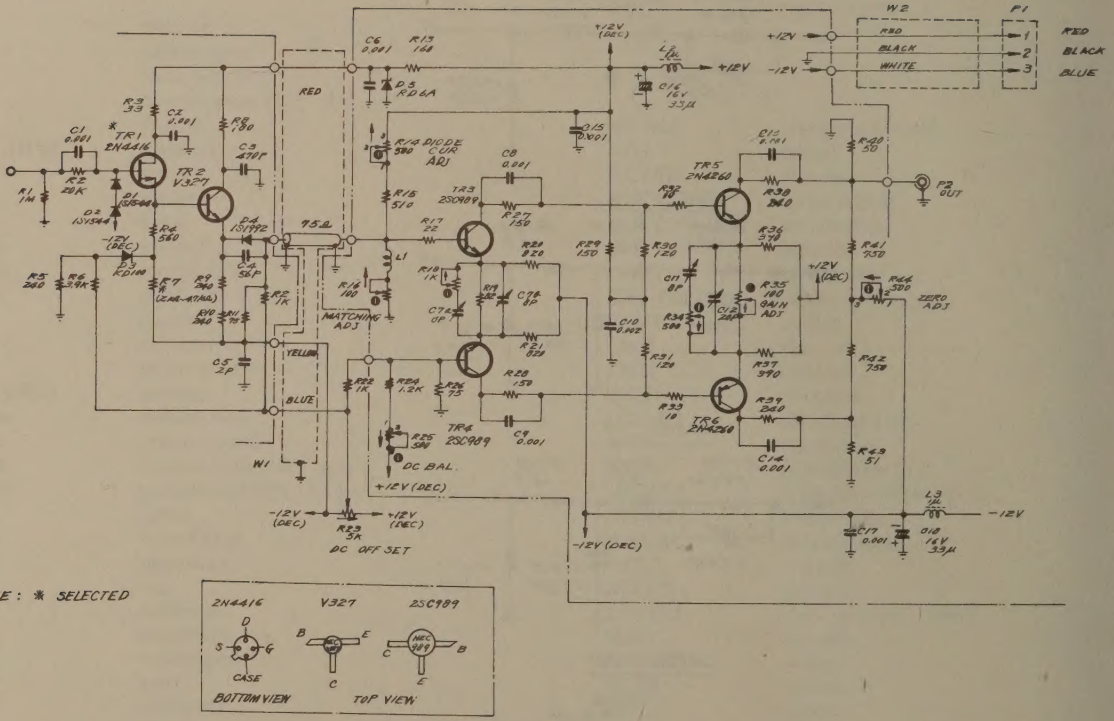
- **Others:**

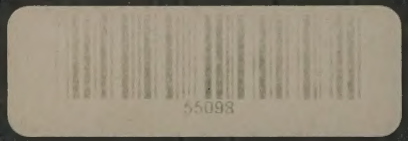
AC (ac)	alternate current
ADJ	adjust
ALTER	alternate
ASTIG	astigmatism
AUTO (Auto)	automatic
BAL	balance
CAL	calibrated
CAL OUT	calibrator output
CENT	center
CH 1	channel 1
CH 2	channel 2
CHOP	chopped
DC (dc)	direct current
EXT	external
GND	ground (earth)
HF REJ	high frequency reject
HORIZ	horizontal
ILLUM	illumination
INT	internal
INTEN	intensity
LF REJ	low frequency reject
MAG	magnifier
NORM	normal
SENS	sensitivity
SWP	sweep
TRIG	trigger
UNCAL	uncalibrated
VERT	vertical



ATTENUATOR & CAPACITOR

P-603722


W2
P1
RED
BLACK
WHITE
+12V
-12V
TR1 2N4416
TR2 V327
TR3 2SC909
TR4 2SC909
TR5 2N4260
TR6 2N4260
D1 ISV544
D2 ISV544
D3 RD10M
D5 RD6A
DIODE CUR ADJ
MATCHING ADJ
DC BAL.
DC OFF SET
GAIN ADJ
ZERO ADJ
P2 OUT
W1
YELLOW
BLUE
75Ω
+12V (DEC)
-12V (DEC)
NOTE : * SELECTED
2N4416
V327
2SC989
BOTTOM VIEW
TOP VIEW
CASE



IWATSU ELECTRIC CO., LTD.